Link Between Academia and Industry for Green IT

Christina Herzog[1], Jean-Marc Pierson[1], Laurent Lefèvre[2]

[1]IRIT, University of Toulouse 3 Paul Sabatier, France
{Herzog, Pierson}@irit.fr

[2]INRIA Avalon Team, LIP Laboratory, Ecole Normale Supérieure de Lyon, Université de Lyon, France
Laurent.Lefevre@inria.fr

ABSTRACT

Technology transfer between different organisms like academia and industry is an important factor for the development of our society. Different organisms mean also different priorities, different points of view and difficulties in working together. Having the same definitions, getting to know the different players, their aims will support the technology and knowledge transfer in order to develop new Green IT technologies. This paper analyzes the various positions of the different possible participants in a project, their different aims but also their common points and how to build bridges for a common understanding of innovative project in the field of Green IT.

Keywords

Green IT, technology transfer

1. INTRODUCTION

Since the last decades Information Technology (IT) is playing an increasing role in our society. But the research was more related to reliability, performance and quality of service than to the ecological impact. Since alarming studies were conducted; academic researchers, governments, funding organisations and companies started research activities in the direction of Green IT [18]. Based on the different definitions [19, 20], and motivations (social, economic, environmental, etc.) a definition of Green IT was stated, which is for now the basis for this work *"Green IT is the environmental and resource saving effort in the IT. The reason for using Green IT may arise from economically or ecologically interests. Actions can affect on the whole lifecycle of information technology - meaning from the construction via utilisation through to disposal."*[9].

Up to our knowledge this paper is one of the first to explore the relation of academia and industry in the field of Green IT. Firstly we have to be aware that Green IT is a part of the IT research, which has to be seen as a general research field, meaning it is also facing the same problems as other research areas do. Each player (companies, researchers, etc.) is having a different access, a different pace and different aims which are making it difficult to have a permanent and an efficient exchange of results. Moreover the different parties may have difficulties in defining common research interests, even if they agree on the scientific part but still there are different backgrounds.

In this perspective, this article deals with general definitions about technology transfers to give common understanding. Secondly, the focus is set on contracted research between academia and industry, comparing the different points of view before contextualizing the purpose to the Green IT field. Some of these differences are examined more closely and propositions for the technology transfer of Green IT are made.

2. TECHNOLOGY TRANSFER WITH/THROUGH MISSION ORIENTATED RESEARCH

The definition of technology, which is used as the base in this article, covers the knowledge of the appliance of scientific knowledge. Scientific cognizance stands in this case for all results and observations of activities in research and development. The constraint that these results had to be received with scientific methods is not taken into account when the transfer is done: Used technologies might be the result of scientific ambitions but also lucky consequences within practice. Finally scientific knowledge in the perspective of this work encompass both empirical and theoretical knowledge; it means all directed processes and methods, including their practical usage and also material artifacts like products, prototypes and software.

Technology is the special knowledge, know-how, in the sense of instructional knowledge and skills. Occasionally knowledge is divided into know-how, know-why, know-what, and know-who, but simplifying all these definitions are summed up under the definition of know-how [23]. In the economical context knowledge is seen as one factor of production respectively as a resource with an important impact on the technical progress (e.g. the virtuous circle in the Green IT that we analyzed previously in [9]) and the long-term development of companies. Technology is the sum of all available procedures of productions in a society. The difference to other production factors is that technology can hardly be measured quantitatively compared to raw materials or capital. The evaluation of the technology potential is therefore very difficult. However, technology is never consumed during the usage or dissemination, the user, the researcher or the teacher is not losing the technology. But technology can lose importance in case of exclusive usage and/or when new knowledge is creating new technology, reducing the value of the previous technology. The particularity of Green IT is the pace of development of new ideas and technologies. These are going on very quickly since there are many opportunities where Green IT can be included (Hardware, Software, Cloud Computing, etc.), speeding up the emergence of new technologies and their disappearance.

Changing the perspective from the generation of technology towards its usage leads to another useful consideration. From this point of view technologies represent all results of research and development contributing to solutions of problems. The

usage of technology suggests linking the term technology to the interaction between scientific/technical perception and the society. This is of particular importance in the field of Green IT because a general awareness about technical possibilities is missing together with a comprehensive study of the user acceptance level for greener solutions at the price of potentially degraded quality of services.

This article does not lodge claim of a complete classification of interactions of parties in all sorts of technology transfers. This is not feasible as classifications can be done with different parameters (vertical, horizontal, product-oriented, procedure-oriented, infrastructure-oriented transfer, etc.) [1, 2, 3]. To examine each interaction in an isolated way has only a limited value for the global point of view. Therefore we decided to focus on two kinds of transfers to reach a profound understanding of the potential interaction of parties. Indeed non-pointed and focused transfers are/will be the most profitable ways of technology transfer in Green IT:

Within the area of non-pointed transfer the technology disposer provides information to (for him) unknown public. The receivers decide about the individual relevance of the information and about the implementation of the information. There is no direct contact between the provider and the receiver. Non-pointed technology transfer is often defined as a process in which ideas are spread from a provider to the receivers [4, 5], in a broadcasting way. These definitions are pointing out the passive diffusion from the origin to receivers using this knowledge. The technology provider offers – knowingly or unknowingly - a potential solution, in general without having an idea of the concrete request. An individual adjustment is not possible due to the missing interaction but it is possible to use, to develop this idea, this result by the receivers. A large set of white papers, recommendations, leaflets made by industry, groups of interest or more rarely researchers are freely available online in the Green IT field, in particular for datacenter construction and operation: EU Code of Conduct for Datacenter (EU CoC), The Green Grid white papers (53 white papers as of today), to name a few.

The basis of the diffusion is the availability of the technology by the producer. This can occur in a communicative way like presentations and publications or by the nature of the technical artefact (for instance open source software).

With the focused transfer it is possible that a precise solution is transferred target-oriented to the recipient. In this situation the partners are in an equal position. Mainly the constructor modifies and develops the technology according to the needs of the user. The developer has an active role as he supports the user in the implementation and in the gainful use. Therefore an interactive relation between the partners is mandatory. This active interaction results in a lot of work but also boosts the success of this technology. This technology transfer is similar to a vendor-client-relation.

The difference between these two models is shown in the observation levels: the process of diffusion, the relation between the parties, the kind of information transferred, the way it is transferred, the receivers of the information. The non-pointed transfer can be seen as a process of diffusion of an ideal innovation in a social system. The interest in the focused transfer is in the microeconomics, highlighting the relation between two or more economic entities. The questions of interest in the non-pointed transfer of technologies are the rate of spread, kind of spread, channel of diffusion, and classification of technology users. In the central research of the focused transfer are the characteristics of the transfer partners, the interaction process, and the implementation process. The non-pointed transfer is uncontrolled, unmanaged and spontaneous; the focused transfer is controlled and precise. Finally a last crucial observation level is to know if the technology constructor sent implicit or explicit information to selected users (e.g. meaning a defined and limited circle of potential users, who he has already a relation with).

Having a non-pointed technology transfer and the offered solution correspond to the challenge of the potential user, then a similar benefit may be achieved as with a focused transfer. The non-pointed transfer cannot replace the focused one but may result into a passage from the non-pointed to the focused transfer - assuming the willingness of both partners.

Similarly, a focused transfer can deliver results openly in the same way as a non-pointed transfer does. For instance, open source software for energy consumption characterization developed in a European project on Green IT like CoolEmAll [24] is offered to the public as a side effect since all partners agreed on a GPL-like license.

3. ANALYZE OF IT-CONTRACTED RESEARCH BETWEEN ACADEMIA AND INDUSTRY

For innovation oriented companies the academic research represents a fundamental resource of external produced technologies. The more the industry is oriented towards novelties on the market and leadership in technology, the more the cooperation with public research institutes is interesting for it. Academic institutes could be considered as the best partners as they have a wide experience in cutting-edge-research but also because their interest is not only focused on one product. They have no business interests, but an interest in independent and fair research - they are impartial! Despite this high synergetic potential academic researcher and industry operate in unconnected systems. In reality there exist a variety of options for arrangements in the cooperation, like patents, licenses, specific consulting. Contracted research is a specific form of focused technology transfer with its challenges and chances for research projects and for future cooperation between industry and research institutes. In the contracted research there is the presumption that the company contracts a research to an university for implementing the result out of this contract in its organization, using this outcome and having an advantage in competition. The contracted research project is the instrument for the technology transfer.

Contracted research is getting more importance during the last years and it is finding also the influence in national and international research programs, calls of tender and open calls [6, 7]. The idea is to define certain criteria for this special way of transfer. The first point is the client-supplier relation, in which the client is a company and the supplier is a research institute. Secondly, it has to be mentioned that the primary purpose of this cooperation is the exchange of scientific knowledge. This exchange is interactive, organizational, service based and focused-mainly between two actors, without a 3rd party involved. Thirdly, the relation is contract-based with a time limit and with the obligation of providing a result, a solution. A particular issue of contracted research is when there is a funding organization (like NSF, EU, etc.) involved as in this case the client-supplier relationship is supervised by this organization: progress reports have to be provided, and the parties have (probably) less opportunities in creating their relationship.

3.1 Comparing academic and company points of view

With a contracted research project a temporary bridge is built between the system of economy and the system of science. To be successful elements of both contexts have to be taken into account and further stimulations have to be provided [8]. The interaction between partners with different background and a different environment is challenging. The internal systems cannot be compared and assumptions may often be wrong because of a lack of knowledge about the other partner. We propose Table 1 "Similarities and differences of academia and industry" in order to give an overview over the various aspects and to point out the important approaches. It presents the different aspects of the two partners of a contracted research.

3.2 Analyses

In the first part of Table 1 there are all the different topics linked to research and innovation in IT. We can see clearly in line A the different core competences pointing out that an exchange between academia and industry is needed to get a very complex outcome. Product development can only be done if there is a good fundamental research provided, and also if the approach is general enough: Like this it gives the opportunity to the industry to propose concrete solutions in answering to various demands concerning different kind of demands. For instance, a solution can be tight to a specific server (typically by a vendor industry) or general enough to encompass a variety of servers and datacenters at various scale.

The second part of Table 1 deals with the criteria and the dissemination where a gap is also seen. Currently Academia mainly distributes their results to the scientific community while industry stakeholders need to address their clients, and their demands. A very known actual topic concerns Server Virtualization, a very good example to see that an exchange is necessary. Server virtualization decreases the number of needed actual servers to handle users' requests to services. On the paper this can save a large amount of energy. But the system has to be developed, to be studied and to be proved before large investments are made. Measurements are needed, different solutions challenged against synthetic and real workloads. Only universities had the opportunity to invest time and to create a platform to do so in early ages of server virtualization. With additional exchange with industry about their demands the result were achieved more quickly and more precisely: Indeed using real trace workloads is the key for researchers to prove their results. Unfortunately these workload traces are often kept secret and not shared by company without contracted research and non-disclosure agreement (NDA). When a first proof of concept has been established, the industry can develop itself its own business, directly with other industry partners, for instance to develop and test solutions for server virtualization in real world at a very large scale only available at large privately owned datacenters.

In the third part of Table 1, we have a look on the organization of the different parties. We can see clearly what may lead to difficulties in the cooperation; both parties have to show some understanding concerning the framework of the other one. What is clearly an advantage of the academia is that they have existing cooperation with other research units in their university, while industry partner often have only one major experience or one major activity. Let's take the example of cooling in server rooms. It may appear that a company is able to build energy efficient servers but doesn't have the experience in modelling the airflow in a datacenter, which is another expertise. It belongs to another industry player for small companies, another department in large groups, can be simply taken from recommendations or best practices developed in the past, or develop with the help of academic partners. Academics do have workshops on a large field of research where they exchange with each other, where they learn from other as well. Academics are linked to other fields of research and they are not in concurrence if they are in different research fields, or at least not at the same level of fierce competition. Having a close link between industry and academic helps to find inexpensive solutions quickly by using the research network of the academic partners

One possibility to build a bridge between different interests is the creation of a Technology Transfer Office (TTO). These offices are dedicated to identify research having potential commercial interest and they develop strategies for exploitation.

3.3 Critics on the model

Before moving on to the contextualization to Green IT, it appears necessary to discuss one hypothesis mentioned hereby: Researchers are impartial, and act for common welfare (line A, Table 1). This idealistic view is naïve especially in a fierce competition for faculty positions and lack of government funding. Indeed a research institute can act like a company except that the benefit is different. It needs third party to build contracted research with. Besides money that allows to hire students, PostDoc and Engineers to conduct researches, the reputation is a key point. Anyway, researchers have to finish in time the projects, in order to keep a position or to get a new one. However we do believe that most of researchers in research institutes would prefer to act differently and we rely on this assumption to build our work, especially in the context of Green IT where societal welfare might be a side-motivation for researchers. Actually one long-term motivation of this work is to improve the technology transfer without the researchers to behave as competitors so that they can return to their fundamental motivation.

4. CONTEXTUALIZING TO GREEN IT

This article will not line out all the above-mentioned points, but will highlight significant examples in the context of Green IT.

4.1 Duties and responsibilities

For the line A in Table 1 there is currently a big hype in our society about all topics related to Green IT. Therefore companies are interested in having a green label on their products or that in their name "Green" is appearing. It is their way of showing that they care about our planet. There are many different aspects making IT to Green IT. It starts with the production over the usage, the energy consumption, the cooling towards the recycling. The individual funding enterprises can get from the State, from individual programs are quite high, therefore they are interested in getting the "green label" [20, 21] even if it is only "green washing". The Industry is more aware of this hype because they see the new market for business and for extending their field of activity than researchers who are more interested in long-term research, in a contribution to the welfare of the society. These two different approaches will also lead to developments into different directions.

4.2 Approach

In line C the different approaches between academia and industry are highlighted. For the industry it is important that a perfect solution (e.g. Datacenter Infrastructure Management-DCIM software ready to use) is presented/proposed. Solutions, which are not costly, working immediately and non high-maintenance products are definitely the ideal outcome. Operating research and development departments in companies prefer simple solutions. Even if with more investments e.g. measuring the load of servers, or thinking about different

methods of cooling the companies could achieve better greener solutions they keep in mind the profit and the management is setting the priorities – see line F.

Then the management decides to buy or not to buy the product (having a look on the costs, the balance of accounts, the penalties for producing CO2), and the last step is the usage of it. The industry is having a very concrete approach: Saving money, having a Green Label, an easy usage.

Academia are interested in searching and finding a better solution than the ones already existing. Researchers are measuring the load of servers, changing the cooling and as a result new DCIM software is developed. There is a general approach as the view of the researchers is broader-they see also the welfare of the society and the interest to improve research-maybe in also other disciplines.

4.3 Criteria of efficiency

Green IT must give more value in terms of money to the company (e.g. stock options must go up, more possibilities for getting new contracts). A company is interested in making money. So for the industry Green IT is only interesting if there are tax advantages, if it helps to save money immediately and directly-companies often forget the impact of electricity consumption and the costs for electricity. As costs for energy are almost a point of discussion (not like costs for stuff) Green IT has to provide clear numbers how much costs can be saved in using Green IT.

For researchers the only criteria of efficiency is the scientific reputation. In the young area of Green IT there are a lot of unsolved problems and plenty of not investigated fields. If researchers propose innovative solutions they can get a higher reputation, which is their main interest, beside the extension of knowledge. Actually their motivation is reputation, i.e. the number of published papers (and not research results) and even if it means to re-invent the wheel, they would do so with sometimes and for some of them a short term perspective.

There are not a lot of conferences dedicated not only to technical Green ICT but also including other overlapping research topics like management or business process, where researchers can confront their ideas with industry players, having a high reputation in this still young research field. For instance, IEEE IGCC [10] started only in 2009, ACM/IEEE e-Energy [11] in 2010, IEEE GreenCom [12] in 2010, while workshops attached to larger events started a bit earlier (HPPAC [13] in 2005 or E2GC2 [14] in 2009), and so on and are mainly technical conferences. Academic journals on sustainable computing or Green IT have been launched only recently by major publishers ([17] in 2011 for instance). Academic initiatives attracting interests such as Green500 [15] or the European COST Action IC0804 [16] are also not very old compared with traditional computer science.

For researchers it is mandatory to publish paper in well established conference or journals, and at the same time to reach a large community interested in energy saving. This duality makes it therefore more limited to progress in their carrier than in other well-established fields of research. Researchers may prefer to publish in other related medium to increase their visibility and reputation (for instance conferences existing since 20 years having some tracks on Green IT rather in specialized events organized since only a couple of years). These events/journals have a higher impact (e.g. a higher Impact Factor, a better conference ranking) leading to be more appreciated by researchers. And where will these researchers not meet numerous members of their community on Green IT as compared to a specialized event.

This criteria in the field of efficiency shows totally divergent points of view, and may result in difficulties in the transfer of technology and building up a long lasting cooperation.

While for research institutes it is more important to have a general approach, to look after complete solutions, applicable in many cases. Costs are less important, and also the time, which is needed to achieve results, is not the main interest of the research institute, except when a contract is established with a industry player as mentioned before.

4.4 Freedom of Action

The research institutes are opened concerning new approaches, new ideas. The researchers are free in their decision which research to bring forward and where to put the focus but they have limits through resources like stuff, funding. Many open public calls, where Green IT is present, are limited to iterative research even if Green IT would allow breakthrough research. This effect may lead to difficulties between researchers and the management as the company sold a certain result to one of the clients and is not able to change the contract, even if the solution proposed by researchers having better results in saving energy.

5. CONCLUSION

Green IT is a rather young research area and therefore there are still a lot of topics to explore. Still there is a strong change in the different areas of IT, with the tendency to Green IT as it is a strongly discussed topic in our society. Energy saving, protection of resources, recycling, limited possibility in the utilization of technology are catchwords which are accompanying our society. Green IT is a part of this discussion and its involvement in different research field has to get stronger. Green IT has been recently embraced in different manners by academic researchers and industrial leaders. This should happen in a strong exchange with researchers of different fields but also in including companies, even if they are not at the first sight in the IT field. It is necessary to enforce the cooperation between academia and industry to advance in the Green IT for our society. To achieve this TTOs should be integrated in research centres, where technical knowledge is collected, but also the knowledge of funding possibilities and contact data are prepared for usage for Green IT. As Green IT is a young research field it is still possible to build up good databases and to follow the innovations. These TTO are points of contact for companies and for researchers. Even the creation of spin-offs could be integrated in their activity field. As these offices are a part of the academia they are also in the centre of innovation and research and they can connect researchers with a research result easily with the companies working in this field. On the other hand companies should use the concept of Angel investors for financing projects and collaborations. An innovative idea can be funded by investors and have a big impact on the society, while waiting until the next open call from a funding organization may just be a loss of time and at the end this innovative idea will never be provided-neither to the research nor to the society.

Due to pointing out the different objectives, aims and approaches in Table 1 we are convinced that there will be a better understanding between the partners, but also that there will be a change in the cooperation and in the transfer of knowledge due to the better understanding between industry and academia but also there will be a change in the different funding systems. Future works will have to be done in investigating more in details the current difficulties, developing the understanding of the partners and pointing out more clearly the needs of having a permanent exchange between industry, academia and funding organizations.

			Academia	Industry
Research and Innovation process	A	Duties/responsibilities	Common welfare Extension of knowledge	Profit orientation Offering service and products for the market
	B	Core competence	Fundamental research in Software and Hardware User oriented research Experimental research	User oriented research Experimental research Product development
	C	Approach	Search and find General	Decide and act Concrete
	D	Priorities of topics	Personal interests Expected appreciation Financing	Strategic development of the company Portfolio of the products
	E	Selection of topics	Autonomic Funding relevant	Innovation management Top management
Criteria and dissemination	F	Criteria of efficiency	Scientific reputation	Profit and company value
	G	Criteria of quality of the work	Systematic production Reconstructable processes and results Big application area Explanatory contribution	Usability of the results Big effects for the clients usage Advantageous economic solution for a concrete application areal Production of an innovation leading to a temporary monopoly position
	H	Reference groups	Scientific community student	Clients Other units within the company
	I	Distribution of the results	Conferences Publications Patents	Products Internal processes Services Patents
Organisation	J	Freedom of action	High Limited through resources (funding, staff, equipment, …)	Average limits through managment
	K	Funding	Non-performance related basic financing Calls of funding organisations Services for companies	Budget of the innovation management In-house accounting
	L	Organisational framework	Fixed and solid Influenced through scientific community Need safety concerning the expenses	Flexible Influenced through market needs, clients'needs Searching for information about efficiency and risk
	M	Relation with other units of the organisation	Limited administrative support is offered Interaction within a given framework Parallel units with other fields of competences	Part of a chain within the company Targets given by the management

Table 1: Similarities and differences of academia and industry

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